Community Air Quality Monitoring: Special Studies

Fresno

Fremont Elementary School

May 2006

California Environmental Protection Agency
Air Resources Board

Executive Summary

This report presents the final results from a special air quality monitoring study at Fremont Elementary School, in Fresno. The California Air Resources Board (ARB) conducted the study as part of a larger statewide evaluation of the adequacy of the State's air quality monitoring network as required by the Children's Environmental Health Protection Act (Escutia, Senate Bill 25, 1999 (SB 25)).

Contents

The ARB selected Fresno, a community in the San Joaquin Valley, to investigate the impact of traffic and other air pollution sources on children's exposure to air pollution. The Fresno school system is the 4th largest in California with over 80,000 students in 61 elementary schools, 16 middle schools, and 9 comprehensive high schools.

Fremont Elementary School was chosen as the air-monitoring site for this study. It is located at 1005 W. Weldon, which is approximately one half mile east of Highway 99. Fremont Elementary School is also part of the Fresno Asthmatic Children's Environment Study (FACES), an epidemiological study of air pollution on children with asthma. [1] Air monitoring at Fremont Elementary School was completed during a 15-month period, from June 2002 to August 2003. In this study, data from Fremont Elementary School was compared to data from the nearest long-term monitoring site, Fresno – 1st Street, for the same time period. Both Fremont Elementary School and the Fresno – 1st Street site are located in Fresno. The results are briefly described below.

Ambient One-Hour Ozone Standards

Fremont Elementary School exceeded the federal one-hour ozone standard on 9 occasions, while the Fresno – 1st Street site exceeded the federal one-hour ozone standard 14 times during the same time period.[2] With respect to the State one-hour ozone standard, Fremont Elementary School exceeded the State standard 56 times, and the Fresno – 1st Street site exceeded the State standard 71 times. Overall, the

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[1] FACES is a five-year study, which began in 2000, followed 300 children to determine how various environmental factors influence the way a child's asthma progresses over time. In an effort to obtain more comprehensive air quality data some of the monitoring systems used for the FACES study were different than those used at the routine air monitoring stations. Information regarding this project can be found on the ARB website at http://www.arb.ca.gov/research/faces/faces.htm.

[2] U.S. EPA rescinded the federal 1-hour ozone standard in July of 2005. This report was written prior to this action; the report's analyses are based on the old federal 1-hour ozone standard.

ozone values at Fremont Elementary School were lower than what was measured at the Fresno – 1st Street site.

Ambient PM_{10} Standards

Fremont Elementary School exceeded the State PM10 standard on 16 occasions, while the Fresno – 1st Street site was above the standard on 10 occasions. However, because of the special requirements of the FACES study, Fremont Elementary School and the Fresno – 1st Street site used different types of PM10 monitors. For this reason, we cannot conclusively determine whether these differences were due to differences in pollution levels or to monitoring methods.

Ambient CO Standards

Fremont Elementary School, like many other areas in the San Joaquin Valley, did not exceed the State standards for carbon monoxide (CO). CO levels at Fremont Elementary School were only slightly higher than the Fresno – 1st Street site, but were still well below the State standard.

Ambient NOx Levels

The average level of NO_x at Fremont Elementary School was higher than those measured at the Fresno – 1st Street site and is possibly associated with the impact of higher traffic levels in the area of the school.

Toxic Air Pollutants

When assessing the impact of toxic air pollution, the study found that the estimated potential cancer risks at Fremont Elementary School were higher than the risk estimated for Fresno – 1st Street, and the statewide urban average. The levels of benzene and 1,3-butadiene accounted for most of the estimated potential cancer risk at both sites. Since motor vehicles are the primary source of both these pollutants, heavy traffic levels on Highway 99, located about ½ mile from the school, could be attributing to the higher potential cancer risk levels at Fremont Elementary School.

As mentioned previously, the air monitoring conducted in Fresno was conducted as part of the effort to evaluate the statewide air quality monitoring network as required by SB25. This evaluation is contained in a report titled *The Assessment of California's Statewide Air Monitoring Network* (Adequacy Report). The Adequacy Report was written before all of the 2002 and 2003 data from the Fresno sites used in this report were available. As a result, the analyses and findings relating to Fresno in the Adequacy Report may differ somewhat from those contained in this report. In addition, you can locate all of Fresno's air monitoring data at: (http://www.arb.ca.gov/ch/aq_result/fresno/fresno.htm)

Introduction

Investigating the relationship of air pollution to children's health is an ongoing priority at the ARB. The ARB has sponsored many studies on the health effects of children and their exposure to air contaminants. These and other studies indicate that children:

- are more vulnerable to environmental contaminants than adults;
- have higher exposure compared to adults relative to their body size;
- breathe more air on a comparable scale; and
- tend to be more active and breathe more rapidly than adults — therefore taking in larger doses of air contaminants.

In the long term, exposure to air pollutants can adversely affect the development of children's lungs, heart, and immune systems.

The Children's Environmental Health Protection Act

In recognition of children's vulnerability to air pollution, the California Legislature enacted the Children's Environmental Health Protection Act (Escutia, Senate Bill 25, 1999 (SB 25)). This legislation directed the ARB to take additional steps to ensure that the State's air pollution programs are protective of children's health. These steps include:

- a review of air quality standards to ensure children are protected;
- an evaluation of the adequacy of the current outdoor ambient air monitoring network to gather data necessary to determine children's exposure, including special monitoring studies in six communities in air pollution non attainment areas around the State; and
- the review and development, where needed, of air toxic control measures to protect children's health.

SB 25 also requires the Office of Environmental Health Hazard Assessment (OEHHA) to identify those pollutants that are most harmful to children. In 2001, OEHHA released the final report, *Prioritization of Toxic Air Contaminants – SB25* (http://www.oehha.ca.gov/air/toxic_contaminants/SB25finalreport.htm). ARB must then review affected airborne toxic control measures (ATCMs) for these toxic air contaminants to ensure they adequately protect infants and children. ARB's ATCM efforts are ongoing. The focus of this report is on air monitoring conducted in Fresno, California during the period of June 2002-August 2003. Real time air quality data for Fresno can be found in ARB Air

Quality and Meteorological Information System (AQMIS). This database can be found on the ARB webpage at: http://www.arb.ca.gov/aqd/aqinfo.htm.

Fresno Air Quality Monitoring Study

As part of the effort to evaluate the adequacy of the current ambient air monitoring network, the ARB conducted special monitoring in six locations throughout the State where children are typically present. The six communities are Barrio Logan, Boyle Heights, Crockett, Fruitvale, Wilmington, and Fresno. The focus of this report is on the air monitoring conducted in Fresno, a community in the San Joaquin Valley of California. The ARB conducted the air monitoring in Fresno during a 15-month period, from June 2002 to August 2003.

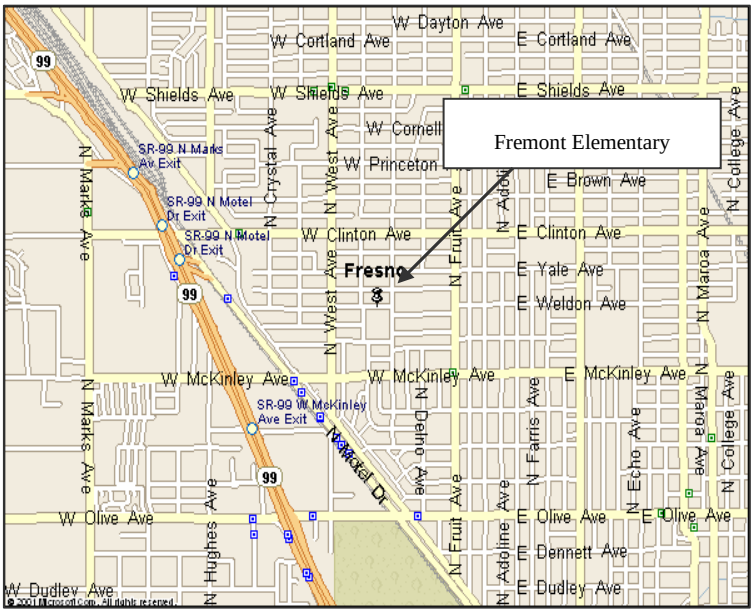
The report summarizing the overall evaluation of the adequacy of the statewide air monitoring network is entitled *The Assessment of California's Statewide Air Monitoring Network* (Adequacy Report). It can be found at http://www.arb.ca.gov/ch/programs/sb25/adequacy.htm. The Adequacy Report was written before all of the 2002 and 2003 data from the Fresno sites used in this report were available. As a result, the analyses and findings relating to Fresno in the Adequacy Report may differ somewhat from those contained in this report.

Description of the Fresno Air Monitoring Study

Site Selection

The ARB selected Fremont Elementary School as the Fresno study site to investigate the impact of mobile source emissions, and other air pollution sources on children's exposure to air pollution and to evaluate the ability of the State's permanent air monitoring network to gauge that exposure. As shown in Figure 1, Fremont Elementary School is located next to a major freeway that is a significant source of vehicular emissions. Other emission sources

Figure 1. Fresno Monitoring Site



impacting Fremont Elementary School include rail yards and distribution warehouses. A large distribution center with compressed natural gas fueled vehicles for local delivery, as well as large diesel and gasoline-fueled trucks is located at the intersection of McKinley and Highway 99, which is approximately one half-mile away from Fremont Elementary School. In addition, the data from this site was used as a part of the Fresno Asthmatic Children's Environment Study (FACES). FACES is an epidemiological study of the effects of air pollution on children with asthma. Information regarding this study can be found on ARB's website at: http://www.arb.ca.gov/research/faces/faces.htm.

Pollutants Sampled

Outdoor air samples for over 50 air pollutants were collected at Fremont Elementary School during a 15-month period from June 2002 to August 2003. The sampled pollutants included both toxic air pollutants and others known as "criteria pollutants" that contribute to smog and particulate matter. Table 1 lists the key pollutants measured and reviewed for this report. The other 31 pollutants measured are not listed in Table 1, because the measured values were very low or not detectable. Particulate matter from diesel-powered engines, an important contributor to cancer risk, was not directly measured as part of this study. Monitoring methods for diesel particulates and some other air pollutants that may cause adverse health effects are still under development.

Table 1. Key Pollutants Monitored in Fresno

Fresno	
Toxic Air Pollutants	**Criteria Pollutants**
1,3-butadiene	Particulate matter
Benzene	Fine Particulate matter
Acetaldehyde	Ozone
Formaldehyde	Carbon monoxide
Perchloroethylene	Oxides of nitrogen
Carbon tetrachloride	
Methylene chloride	
Para-dichlorobenzene	
Hexavalent chromium	
Polycyclic aromatic hydrocarbons	
Arsenic	
Lead	
Manganese	
Nickel	

Toxic air pollutants are known or suspected to cause cancer or other serious illnesses. Criteria pollutants, such as ozone and particulate matter are pollutants for which health-based criteria or air quality standards have been established. The standards establish the levels above which a criteria pollutant may cause adverse health effects in humans.

California's Air Monitoring Network

The State's ambient air quality monitoring network is a key tool in measuring air quality in California and for determining the public's exposure to air pollution. The data collected by this network of over 250 air quality monitoring sites are used to:

- track progress towards clean air;
- help determine exposures to sensitive populations, such as children and the elderly;
- help evaluate which pollutants in the outdoor air present the greatest hazards and thus help the ARB establish priorities for control;
- guide the announcement of "Spare the Air" days and other potentially hazardous conditions; and
- investigate the relationships between air pollution and children's health.

Real time air quality data can be found in ARB Air Quality and Meteorological Information System (AQMIS). This database can be found on the ARB webpage at: http://www.arb.ca.gov/aqd/aqinfo.htm.

Fremont Elementary School Data Compared to Long-term Monitoring Sites

Air quality measurements from Fremont Elementary School were compared to measurements from the closest permanent air quality monitoring site: Fresno – 1st Street (see Figure 2). As shown in Figure 2, Fremont Elementary School is located approximately ½ mile east of Highway 99 and Fresno – 1st Street is about 4 miles northeast of Fremont Elementary School.

Criteria pollutant
An air pollutant with established safety thresholds and standards.

Figure 2. Fremont Elementary School and the Fresno – 1st Street site

Air Monitoring Results for Criteria Pollutants

Criteria pollutants can cause lung damage, heart problems, and in some cases, premature deaths. Based on the health and environmental impacts of these pollutants, State and Federal air quality agencies have identified safety thresholds and established air quality standards for these pollutants to protect public health.

Five criteria pollutants — particulate matter that is 10 microns in diameter and smaller (PM_{10}), particulate matter that is 2.5 microns in diameter and smaller ($PM_{2.5}$), ozone, carbon monoxide (CO), and oxides of nitrogen (NOx), — were measured at Fremont Elementary School. These pollutants are also routinely measured at the Fresno – 1st Street, which is the closest long-term monitoring site.

Particulate Matter (PM_{10})

The very small size of PM_{10} allows the pollutant to reach deep in the lungs where it may be deposited and cause adverse health effects. Major sources of PM_{10} in California include motor vehicles, area-wide sources such as dust from construction and landfills, wood-burning stoves and fireplaces, wildfires and brush/waste burning, and industrial facilities. PM_{10} can also be formed in the atmosphere through chemical reactions between other air pollutants.

Statewide PM_{10} emissions increase from 1975 to 1990, then decrease slightly in 1995 and 2000, and slowly increase after 2000. This increase is primarily the

result of increased fugitive dust from paved and unpaved roads, reflecting the growth of vehicle travel in California. However, statewide emission estimates of diesel particulate matter, which poses the most significant health risk, dropped 40% from 1990 to 2000 due to stricter emission standards and the introduction of cleaner fuel.

Table 2 summarizes PM_{10} levels measured on the same dates at Fremont Elementary School and the Fresno – 1st Street monitoring site over a 15-month period (June 2002 through August 2003). The Fremont Elementary School site used a different type of instrument to measure PM10 than was used in the other SB25 monitoring studies because the data from this site was also used as part of the FACES study. As part of the FACES effort, the Fremont Elementary School site used a continuous beta attenuation monitor (BAM) to measure hourly PM10 levels rather than the filter based PM10 monitor used at Fresno 1st Street. While both methods are approved for recording exceedances of the state PM10 standard, ARB staff is still evaluating ways to compare the results between continuous (BAM) and 24-hour (filter) monitoring methods.

Table 2. Particulate Matter (PM10) from June 2002 through August 2003 (1)

Location	Average (2)	Maximum (3)	Number of Days Above State Standard (4) (15 months)
Fresno-Fremont Elementary	42	115	16 out of 68 days
Fresno – 1st Street	33	96	10 out of 68 days

1. Values are 24-hour average concentrations based on matching days for PM10 BAM daily averages of hourly values (minimum of 18 valid hours per day) at Fremont Elementary and PM10 24-hour filter-based concentrations at Fresno – 1st Street.
2. Values are 24-hour average concentrations reported in units of micrograms per cubic meter ($\mu g/m^3$). The average was based upon the mean of monthly means, where the months of June 2002, February 2003, and August 2003 only have three valid matching days and all of the other months have four or more matching days.
3. Maximum is defined as the highest 24-hour sample measured at that location.
4. Particulate matter standards –Federal 24-hour average: 150 micrograms/m^3 ($\mu g/m^3$); State 24-hour average 50 $\mu g/m.^3$

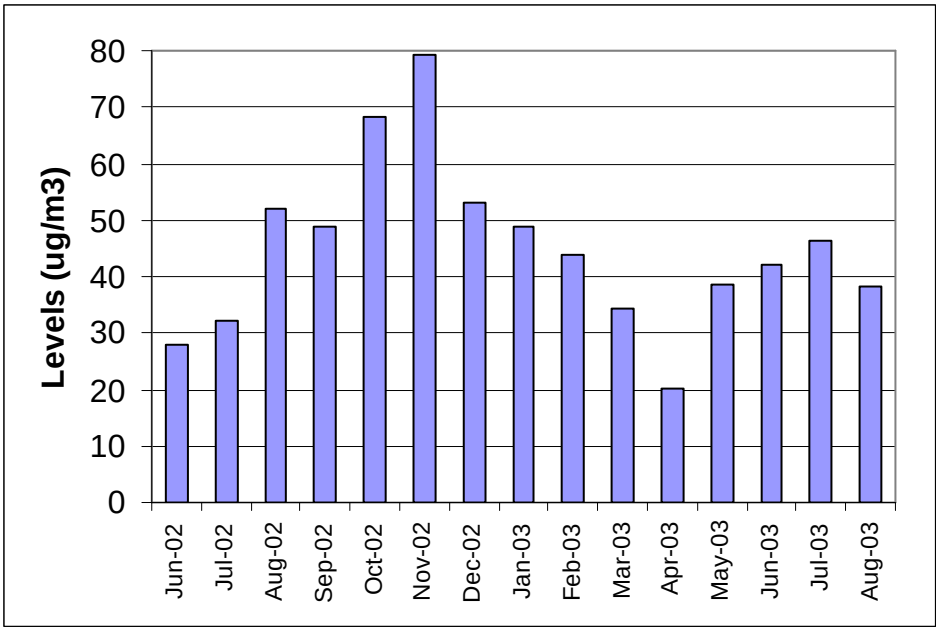
Based on the measurements using the two types of instruments, the 24-hour State PM10 standard ($50\mu g/m^3$) was violated at both sites. The BAM monitor at Fremont Elementary School recorded 16 exceedances of the State PM10 standard, while the filter sampler at Fresno 1st Street recorded 10 exceedances of the State PM10 standard over the same period. Even though the PM10 concentrations

measured at Fremont Elementary School were higher than those measured at the Fresno – 1st Street site, we cannot conclusively determine whether these differences were due to differences in pollution levels or monitoring methods.

Seasonal Variation

The PM10 collected at Fremont Elementary School shows evidence of seasonal variation. PM10 concentrations are highest in the late fall and lowest during the spring. Peak PM10 concentrations occur in the late fall due to dry conditions over the preceding summer months, reduction and/or curtailment of agricultural irrigation activities, and peak levels of agricultural activity due to harvesting, land preparation, and planting. PM10 concentrations decrease during the winter rainy season and begin to increase with the onset of dry weather and spring agricultural activities. The seasonal pattern of PM10 at Fremont Elementary School is shown below (Figure 3).

Figure 3. PM_{10} Monitored at Fremont Elementary School



Fine Particulate Matter ($PM_{2.5}$)

PM2.5 describes the "fine" particles that are less than or equal to 2.5 micrometers in diameter. Fine particulate matter (PM2.5) is the general term used for a mixture of solid particles and liquid droplets found in the air. These fine particles are so small that in some cases they can only be detected with a microscope. The monitoring systems used at both locations were the BAM units making the comparison of data more straight forward.

Table 3. Fine Particulate Matter ($PM_{2.5}$) from June 2002 through August 2003

Location	Average (1) $\mu g/m^3$	Maximum 2)	Number of Days Above Federal Standard (3) (15 months)
Fremont Elementary School	25	111	21 out of 419 days
Fresno – 1st Street (4)	25	100	16 out of 378 days

1. The average is based upon the mean of monthly means. Most months contain at least 23 daily maximum 8-hour concentrations except for June 2002 and August 2003. Values are 24-hour average concentrations based on PM2.5 BAM daily averages of hourly values reported in units of micrograms per cubic meter ($\mu g/m^3$).
2. Maximum is defined as the highest 24-hour sample measured at that location.
3. Federal fine particulate matter standard—Federal 24 hour average: 65 micrograms/cubic meter ($\mu g /m^3$).
4. Fresno-First Street did not have PM2.5 BAM data collected from 3/28/03 to 5/19/03.

As shown in Table 3, overall fine particulate matter average values were the same between Fremont Elementary School and the Fresno – 1st Street site. Fremont Elementary School had more days above the Federal fine particulate standard, as well as a higher maximum value for PM2.5. Over a period of 15 months, the study measured PM2.5 levels above the Federal fine particulate standard (65 $\mu g/m^3$) on 21 days at Fremont Elementary School and 16 days at the Fresno - 1st street site.

Ozone

Ozone is a product of the chemical reactions of nitrogen oxides and volatile organic compounds in the presence of sunlight and is a major component of what is commonly referred to as smog. Near the earth's surface, ozone can cause breathing difficulties and even lung damage. Ground-level ozone can also damage vegetation, buildings, rubber, and plastics.

Currently, large portions of the State do not meet the federal or State air quality standards for ozone. The ozone problem in the San Joaquin Valley ranks among one of the most severe in the State. The number of national one-hour ozone standard exceedance days has been quite variable over the years. This variability is due, in part, to annual variations in weather patterns.

Table 4. Ozone from June 2002 through August 2003

Location	Average[1] (ppb)	Maximum [2] (ppb)	Number of Days Above State Standard [3]	Number of Days Above Federal Standard [4]
Fremont Elementary School	65	146	56	9
Fresno – 1st Street	66	144	71	14

1. Average is the average of all daily one-hour maximum concentrations measured at that location. The average is based upon the mean of monthly means. Most months contained at least 23 daily maximum one-hour average concentrations except for the following months June 2002 and August 2003.
2. Maximum is the highest one-hour concentration measured at that location.
3. State Ozone standard— State 1 hour: 90 ppb.
4. Federal Ozone standard—Federal 1 hour: 120 ppb.

As summarized in Table 4, the average of all one-hour ozone concentrations measured at Fremont Elementary School was compared to those routinely measured at the Fresno – 1st Street site. The federal one-hour ozone standard (120 ppb) was exceeded at both Fremont Elementary School and the Fresno – 1st Street site. Over a period of 15 months, the study found ozone levels above the State standard (90 ppb) on multiple days at both sites in Fresno. Fremont Elementary School exceeded the federal one-hour ozone standard on 9 occasions, while the Fresno – 1st Street site exceeded the federal one-hour ozone standard 14 times. Fremont Elementary School exceeded the State one-hour ozone standard 56 times, and the Fresno – 1st Street site exceeded the State one-hour ozone standard 71 times.

The ozone problem in the San Joaquin Valley ranks among one of the most serious in the State. Ozone levels have fluctuated over the last two decades in the San Joaquin Valley. From 1990 to 2004, there was a 55 percent decrease in the three year average of the number of exceedance days of the national 1-hour standard. The ARB has identified the San Joaquin Valley Air Basin as both a contributor and a receptor for ozone transport.

The ARB anticipates progress toward reducing ozone through the continued adoption of aggressive emission controls on motor vehicles and other sources. More recent ozone trends for the San Joaquin Valley can be found at the AQMIS website at: http://www.arb.ca.gov/aqd/aqinfo.htm.

Carbon Monoxide

Carbon monoxide (CO) is a colorless, odorless gas at room temperature. It is readily absorbed through the lungs into the blood, causing insufficient oxygen to

reach the heart, brain, and other tissues. The resulting harm can be critical for people with heart disease, chronic lung diseases, and anemia as well as for unborn children.

CO is formed as a result of incomplete combustion of fuels and waste materials such as gasoline, diesel fuel, wood, and agricultural debris. Mobile sources generate most of the CO emissions in California. The contribution of industrial sources to overall CO emissions is small. Currently, CO levels in most areas of California are below the State standard, so CO is a diminishing problem in California.

As shown in Table 5, CO levels at Fremont Elementary School are slightly higher than the Fresno – 1st Street site, but both sites are only a little over one half of the State standard. The higher values may reflect higher traffic activity in the Fremont Elementary School area. Much of the progress in reducing levels of CO is attributable to new motor vehicle emission controls and the introduction of cleaner fuels. The ARB expects further reductions of CO levels statewide.

Table 5. Carbon Monoxide from June 2002 through August 2003

Location	Average (1) (ppm)	Maximum (2) (ppm)	Number of Days Above State Standard (3)
Fremont Elementary School	1.0	4.9	0
Fresno – 1st Street	0.7	4.5	0

1. Average is the average all daily maximum 8-hour concentrations measured at that location. The average is based upon the mean of monthly means. Most months contain 23 daily maximum 8-hour concentrations except for June 2002, August 2003. Values are 8-hour average concentrations reported in units of parts per million (ppm).
2. Maximum is the highest 8-hour average concentration measured at that location.
3. Carbon monoxide standards: Federal and State 8-hour: 9 ppm.

Oxides of Nitrogen

Oxides of nitrogen (NO_x) contribute to the formation of ozone and particulate matter, both of which are major air pollutants that reach unhealthy levels in many areas of California. NO_x is emitted during the high-temperature combustion of fuels. On-road motor vehicles and other mobile sources currently contribute most of the NO_x emissions in California.

The two major types of oxides of nitrogen are nitric oxide (NO) and nitrogen dioxide (NO_2). Since the State is currently attaining the State standard for NO_2, this report will discuss NO_x.

As shown in Table 6, the average level of NO_x at Fremont Elementary School is approximately 18% higher than those measured at the Fresno – 1st Street site, and is possibly associated with the impact of higher traffic levels in the area. The maximum one-hour concentration at both sites is nearly identical.

Table 6. Oxides of Nitrogen from June 2002 through August 2003

Location	Average (1) (ppb)	Maximum (2) (ppb)
Fremont Elementary School	103	426
Fresno – 1st Street	84	423

1. Average is average of all the daily maximum one-hour average concentrations at that location. The average is based upon the mean of monthly means. Most months contained at least 23 daily maximum one-hour average concentrations except for June 2002 and August 2003. No federal or State standard has been established for NOx. Values are one-hour average concentrations reported in units of parts per billion (ppb).

2. Maximum is the highest one-hour average concentration measured at that location.

Emissions of NO_x from on-road motor vehicles declined by over 35 percent from 1990 to 2005. This decrease has occurred as vehicles meeting more stringent emission standards enter the fleet, and all vehicles use cleaner burning gasoline and diesel fuel or alternative fuels. Emissions from industrial sources have also decreased, largely because of a switch from fuel oil to natural gas and the implementation of combustion controls. However, the ARB continues to work toward reducing levels of NO_x due to its role in the formation of ozone and particulate matter.

Criteria Pollutant Monitoring Summary

As part of the FACES effort, the Fremont Elementary School site used a continuous beta attenuation monitor (BAM) to measure hourly PM10 levels rather than the filter based PM10 monitor used at Fresno – 1st Street. While both of these methods are approved for recording exceedances of the state PM10 standard, ARB staff is still evaluating ways to compare the results between continuous (BAM) and 24-hour (filter) monitoring methods. Based on the measurements using the two types of instruments, the 24-hour State PM10 standard (50μg/m^3) was violated at both sites. Although the PM10 concentrations measured at Fremont Elementary School were higher than those measured at the Fresno - 1st Street site, we cannot conclusively determine whether these differences were due to differences in pollution levels or monitoring methods. PM2.5 average values were the same between the Fremont Elementary School and

Fresno – 1st Street sites. While standards for particulate matter have not been achieved in Fresno, programs are in place for reducing levels of this pollutant.

Fremont Elementary School and the Fresno – 1st Street site exceeded the State and federal one-hour ozone standards. Fremont Elementary School exceeded the federal one-hour ozone standard on 9 occasions, while the Fresno – 1st Street site exceeded the federal one-hour ozone standard 14 times. Fremont Elementary School exceeded the State one-hour ozone standard 56 times, and the Fresno – 1st Street site exceeded the State one-hour ozone standard 71 times. Because ozone is one of the major components of smog, and the fact that the primary source of smog in California is motor vehicles, you can assume that the high values of ozone at both sites could possibly be attributed to the impacts from motor vehicle emissions. Given that the ozone values at both sites were comparable, this could suggest that the ozone problem is regional. The ozone problem in the San Joaquin Valley ranks among one of the most serious in the State. The ARB anticipates progress toward reducing ozone through the continued adoption of aggressive emission controls on motor vehicles and other sources.

CO levels at Fremont Elementary School appeared to be slightly higher than what was measured at the Fresno – 1st Street site. The higher CO levels at Fremont Elementary School could possibly indicate that there are higher traffic levels in the area. NO_x concentrations for both sites are similar to the regional air pollution levels and are well below the State's air quality standards.

You can locate all of Fresno's air monitoring data at: (http://www.arb.ca.gov/ch/aq_result/fresno/fresno.htm)

Main Toxic Air Pollutants Monitored at Fremont Elementary School

Benzene

1,3-Butadiene

Formaldehyde

Acetaldehyde

Perchlorethylene

Carbon Tetrachloride

Methylene Chloride

Air Monitoring Results for the Main Toxic Air Pollutants

Health Effects of Toxic Air Pollutants

Toxic air pollutants can cause adverse health effects, including cancer, asthma, respiratory problems, and other serious illnesses. Cancer risk estimates related to toxic air pollution represent the chance of excess cancer cases in one million people, assuming exposure over a 70-year lifetime.

Monitoring results indicate that the potential cancer risk at Fremont Elementary School is mostly attributable to seven of the toxic air pollutants measured during the study: benzene, 1,3-butadiene, formaldehyde, acetaldehyde, perchlorethylene, carbon tetrachloride, and methylene chloride. Including the other toxic air

pollutants measured at these sites does not significantly change the overall risk at each site nor does it change the overall relationship of cancer risk between sites.

The cancer risk estimates presented in this report do not include diesel particulate matter (diesel PM). Diesel PM is believed to be the primary contributor to health risks from urban toxic air pollutants. From 1990 to 2000, based on emission estimates the overall potential cancer risk from diesel PM decreased 50% in the San Joaquin Valley Air Basin. Cancer risk represents the number of excess cancer cases per million people based on a lifetime (70-year) exposure to diesel PM. Diesel PM was not measured as part of this study because a proven method for measuring it is not currently available. The ARB is in the process of developing methods to measure diesel PM. California already has an aggressive program to reduce diesel PM emissions throughout the State. You can locate the final diesel risk reduction plan by clicking on the link provided below.

(http://www.arb.ca.gov/diesel/documents/rrpapp.htm)

Potential Cancer Risk Estimates for Pollutants in Fresno

The health risk estimates in this report are based on the best available scientific information. Sources of potential uncertainty in these estimates include the unavailability of risk estimates for certain pollutants and limitations in scientific understanding of the pollutants' health effects. Furthermore, our analysis of health risks from toxic air pollutants focused on one potential adverse health effect, cancer, whereas these pollutants may also cause a variety of respiratory, reproductive, and other adverse health effects.

Table 7 shows how much the major toxic pollutants contribute to the overall potential cancer risk. The cancer risk estimates are calculated by multiplying the risk factor by the annual average concentration. Cancer risk estimates represent the chance of excess cancer cases in one million people, assuming these people breathe the average level of the pollutant over a 70-year lifetime. The following discussion of toxic air pollutants is based on all of the data collected on the same dates from July 2002 to June 2003 at Fremont Elementary School and the Fresno – 1st Street site. Hexavalent Chromium measured on the same dates was not provided because Fresno – 1st Street had quarterly averages, which were not comparable to the Fremont Elementary School 24-hour measurements. Because the sites used different measurement methods for hexavalent chromium, the limit of detection (LOD) was different at the two sites. In addition all measurements of para-dichlorobenzene at both sites on matching days were below the limit of detection in therefore not included in this analysis.

Table 7. Annual Average Concentrations and Risk of the Main Toxic Air Pollutants

		Fremont Elementary School (7/2002 – 6/2003)		Fresno – 1st Street (7/2002 – 6/2003)	
Pollutant	Risk Factor (1)	Average Concentration (2) (ppb)	Cancer Risk (3)	Average Concentration (2) (ppb)	Cancer Risk (3)
Acetaldehyde	5	1.59	8	1.48	7
Benzene	93	0.54	50	0.45	42
1,3-Butadiene	376	0.13	48	0.10	39
Carbon Tetrachloride	264	0.09	24	0.09	25
Formaldehyde	7	3.30	24	3.44	25
Methylene Chloride	3	0.12	<1	0.15	<1
Perchloroethylene	40	0.03	1	0.02	1
Total Cancer Risk			**156**		**139**

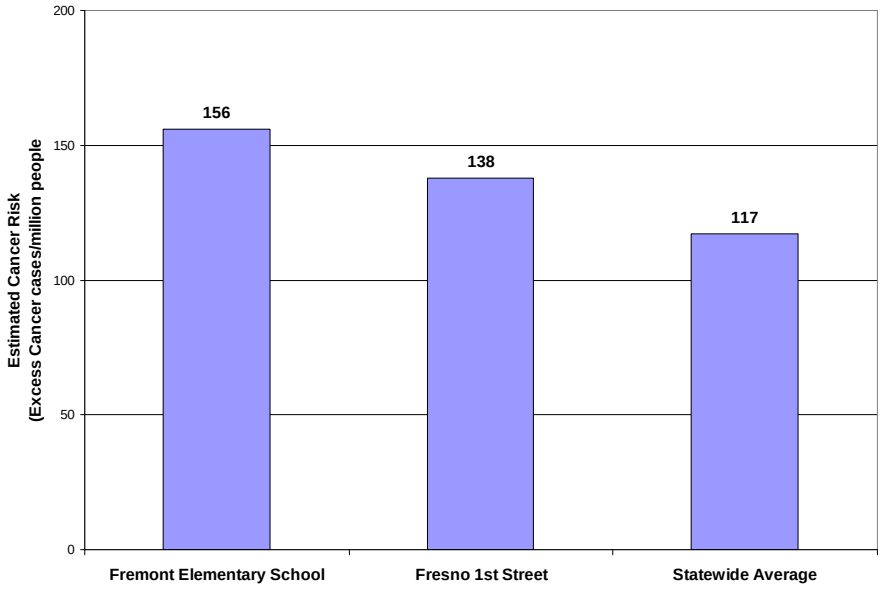
1. Toxicity values for cancer causing air pollutants expressed in terms of risk per unit concentration of the air pollutant given in chances of cancer per million people.

2. The average is an arithmetic mean based on data that are collected on the same days

3. Cancer risk estimates are calculated as (risk factor * average concentration) = cancer risk. Cancer risk estimates represent the chance of excess cancer cases in one million people, assuming these people breathe the average level of the pollutant over a 70-year lifetime. Diesel PM was not measured as part of this study because a proven method for measuring it is not currently available

To put the results from Fremont Elementary School into perspective, ARB staff calculated estimates of potential cancer risk for the main toxic air pollutants at Fremont Elementary School (July 2002 – June 2003) and the nearby long term monitoring site Fresno – 1st Street (July 2002 – August 2003) as seen in Figure 4. In addition, the potential statewide cancer risk estimate was calculated using the same conditions and is included for comparison. The potential cancer risks due to these main toxic air pollutants at Fremont Elementary School was about 11% higher than those estimated for the same toxic air pollutants at the Fresno – 1st Street site. Fremont Elementary School was about 25% higher than the statewide cancer risk estimates for the same seven toxic air pollutants during the time period of 7/2002 – 6/2003.

Figure 4. Potential Cancer Risk[1] for Seven Main Toxic Air Pollutants



1. Figure 4 does not include estimated risk from diesel PM. The potential risk estimate assumes a lifetime exposure through breathing pathway only. Estimates are based on 7/2002 – 6/2003, for matched days only.

Benzene, 1,3-Butadiene, Formaldehyde, and Acetaldehyde

While motor vehicles are the primary source of benzene, 1,3-butadiene, formaldehyde, and acetaldehyde, levels of these pollutants did not follow the same pattern at all sites.

Levels of benzene, 1,3-butadiene, and acetaldehyde were somewhat higher at Fremont Elementary School than what was measured at Fresno – 1st Street, but acetaldehyde was the only pollutant that showed a true statistically significant difference between the two sites. The levels of formaldehyde were higher at the between Fresno – 1st Street site than the Fremont Elementary School. What should be noted about formaldehyde and acetaldehyde is that, while they can be directly emitted into air, they can also be formed when other air pollutants chemically react in the atmosphere. This makes it difficult to identify the origin of these two pollutants impacting each monitoring site.

In addition to increased potential cancer risk, breathing these four pollutants can cause non-cancer health effects:

- 1,3-butadiene can cause neurological effects such as blurred vision, fatigue, headaches, and vertigo at very high levels,
- Benzene can cause central nervous system depression; and

- Acetaldehyde and formaldehyde can irritate the eyes, skin, and respiratory tract.

These non-cancer health effects result from much higher concentrations of these air pollutants than were observed in this study, except for formaldehyde. Formaldehyde can be an irritant for individuals at levels over 2 parts per billion (ppb). The average formaldehyde level measured at Fremont Elementary School was 3.39 ppb, which indicates that some individuals might experience mild irritation during peak exposures. This average is similar to the statewide annual average of formaldehyde, which was 3.4 ppb in 2003. In 2004, approximately 68% of the formaldehyde emissions in the San Joaquin Valley Air Basin came from mobile sources. Formaldehyde is the only toxic air pollutant for which routine air monitoring has shown that measured levels consistently above the levels for which any non-cancer health effects might occur.

Emissions of all four of these toxic air pollutants have been reduced in California through aggressive regulations requiring motor vehicle emission controls, gasoline vapor recovery systems, and cleaner fuels. From 1990 to 2003, outdoor statewide levels declined 66 percent for 1,3-butadiene and 77 percent for benzene. Data for acetaldehyde and formaldehyde are more variable, but levels have decreased significantly since 1990. The ARB has regulations in place to further reduce emissions for all four pollutants.

Perchloroethylene

Levels of perchloroethylene, a persistent organic pollutant, were similar at Fremont Elementary School and the Fresno – 1st Street site. Perchloroethylene can irritate the eyes and respiratory tract, and can also depress the central nervous system. Industrial processes and dry cleaners are the major sources of emissions of perchloroethylene and other chlorinated pollutants. ARB's control measures on dry cleaning facilities have helped to reduce levels of perchloroethylene statewide, but more needs to be done. Controls on degreasers used for automotive maintenance and repairing that are already in place should further reduce levels of this pollutant. You can locate ARB's ATCM for emissions of perchloroethylene from Dry Cleaning Operations at (http://www.arb.ca.gov/toxics/atcm/percatcm.htm)

You can locate all of ARB's Automotive Maintenance and Repair ATCM activities at: (http://www.arb.ca.gov/toxics/amr/amr.htm)

Carbon Tetrachloride

Average levels of carbon tetrachloride at Fremont Elementary School were the same to those measured at the Fresno – 1st Street site. Since carbon tetrachloride emissions are very low in California, levels throughout the state are relatively constant. In fact, carbon tetrachloride levels are fairly constant around the globe, the lingering effect of past use. Carbon tetrachloride takes about 50 years to break down in the atmosphere.

Air Monitoring Results for Other Toxic Air Pollutants

In addition to the criteria and toxic air pollutants discussed above, other air pollutants related to industrial sources near Fremont Elementary School were measured as part of this study. These pollutants were either measured at very low levels or were below the levels of detection.

Hexavalent Chromium

Limit of detection
The lowest concentration of a substance that can reliably measured.

Nanogram
One billionth of a gram

The amounts of hexavalent chromium in most samples collected at this site were below the limit of detection. From August 2002 – August 2003 only 7 of the 61 samples from Fremont Elementary School measured above the limit of detection, with a maximum of 0.29 nanograms per cubic meter (ng/m3). In this study, hexavalent chromium measurements were not used in the risk estimates because they were collected from each site using different monitoring methods. In addition, hexavalent chromium data was not available during June and July of 2002 due to sampler malfunction. To reduce the risk, California adopted a control measure in 1988 to reduce emissions of hexavalent chromium from chrome plating: as a result, statewide levels have been reduced.
You can locate all of ARB's hexavalent chromium ATCM activities at:
(http://www.arb.ca.gov/toxics/ATCM/chroatcm.htm)

Other Metals

Several metals, including manganese, nickel, and lead, were comparable at Fremont Elementary School and Fresno 1st – Street. However, the measured levels of these metals are not high enough to pose a significant health risk. For instance, while the average level of manganese at Fremont Elementary School was 38 ng/m^3, with a maximum value of 120 ng/m^3. The threshold above, which there is some health concerns, is 200 ng/m^3. Sources of these metals include industrial and commercial operations as well as motor vehicles.

Levels of arsenic in Fremont Elementary School were higher when compared to the average statewide levels. The statewide average concentration of arsenic

during (1998-2001) was 1.65 ng/m^3. Relative to the statewide average, Fremont Elementary School was 28% higher, with an average concentration of 2.3 ng/m^3. The maximum value of arsenic at Fremont Elementary School was 10 ng/m^3. The threshold above, which there is some health concerns, is 30 ng/m^3. The primary industrial sources of arsenic in California are electrical services and metal mining. Arsenic is also used in insecticides, weed killers, fungicide, and as a wood preservative.

Methylene Chloride and Para-dichlorobenzene

The average levels of methylene chloride and para-dichlorobenzene at Fremont Elementary School were similar to the statewide average concentrations. The levels of para-dichlorobenzene measured at both sites on matched days were all below the limit of detection. Methylene chloride is used as a solvent, as a cleaning agent in plastic manufacturing and as a paint stripper. The statewide annual average concentrations of methylene chloride declined 71 percent from year 1990 to year 2003. Para-dichlorobenzene is used as a room deodorant, in mothballs, and is a registered insecticide. From 1990 to 2003 the statewide ambient perchloroethylene concentration dropped by approximately 77 percent.

ARB is currently working on air toxic control measures to reduce the emissions of para-dichlorobenzene in California. You can locate all of ARB's proposed ATCM for para-dichlorobenzene activities at:
(http://www.arb.ca.gov/regact/conprod/execsum.pdf)

Monitoring Results for Elemental Carbon

Elemental carbon is a material found in particulate matter (PM_{10}). In the past, it has been used as an indicator of, or surrogate for, diesel particulate matter (diesel PM) levels because of the relatively high content of elemental carbon in diesel exhaust particulate. Because diesel PM emissions are of major concern in Fresno, elemental carbon was monitored in this study. Elemental carbon consists of tiny, black, solid particles of soot, most of which are smaller than 2.5 microns. This small size allows the particles to reach deep into the lungs where they may be deposited and result in adverse health effects.

Recently, however, diesel technologies have improved and the diesel fleet has become cleaner. Other combustion processes such as fireplaces, cooking, forest fires, gasoline engines, agricultural burning, and power plants also emit elemental carbon. As emissions from the diesel fleet have decreased, these sources now account for a larger percentage of total elemental carbon in the air. With these changes, elemental carbon alone is no longer a good marker for diesel PM.

Elemental carbon is not routinely monitored, and there are no standards or thresholds established for which levels of elemental carbon are deemed unsafe. ARB used the U.S. EPA-approved method to measure elemental carbon in this study. However, earlier studies have used different analysis methods, so there are no historical regional or statewide values available for comparison.

Fremont Elementary School had a 0.7 $\mu g/m^3$ average of all 24-hour daily average concentrations of elemental carbon (June 2002 – August 2003), with a maximum value of 3.3 $\mu g/m^3$. In 2000, the statewide daily average concentration for elemental carbon was 1.8 $\mu g/m^3$. An hourly concentration of elemental carbon is measured continuously, from that a 24-hour average is obtained for each day, for which the minimum, maximum and average is obtained.

Conclusions

Fremont Elementary School monitoring site in Fresno was chosen to fulfill the Children's Environmental Health Protection Act's requirement to look at the impact of motor vehicle emissions and industrial sources from transportation-related emission sources on locations where children live, learn, and play. This site is also part of the Fresno Asthmatic Children's Environment Study (FACES), an epidemiological study of air pollution on children with asthma. Based on outdoor air measurements collected at Fresno Elementary School along with data from the long-term monitoring site, Fresno – 1st Street, ARB staff found the following patterns in the air quality data.

Fremont Elementary School, like many other areas in the San Joaquin Valley Air Basin, exceeds the State standard for PM_{10}. The State PM_{10} standard (50 $\mu g/m^3$) was exceeded at both Fremont Elementary School and the Fresno – 1st Street site. Fremont Elementary School exceeded the State PM_{10} standard on 16 occasions, while the Fresno – 1st Street site was above the standard on 10 occasions. $PM_{2.5}$ average values were similar between Fremont Elementary School and Fresno – 1st Street.

Fremont Elementary School and the Fresno – 1st Street site had multiple exceedances of the State and federal one-hour ozone standards. Fremont Elementary School exceeded the federal one-hour ozone standard on 9 occasions, while the Fresno – 1st Street site exceeded the federal one-hour ozone standard 14 times. Fremont Elementary School exceeded the State one-hour ozone standard 56 times, and the Fresno – 1st Street site exceeded the State one-hour ozone standard 71 times. Because pollutants that cause the formation of ozone are primarily from motor vehicles, it is reasonable to assume that the frequency of

one-hour ozone standard exceedances at both sites could possibly be attributed to the impacts from motor vehicles. The ARB has identified the San Joaquin Valley Air Basin as both a contributor and a receptor for ozone transport. The ozone problem in the San Joaquin Valley ranks among one of the most severe in the State. The ARB anticipates progress toward reducing ozone through the continued adoption of aggressive emission controls on motor vehicles and other sources.

Fremont Elementary School, like many other areas in the San Joaquin Valley Air Basin, didn't exceed the State standards for CO. NO_x concentrations are close to regional air pollution levels and are well below the State's air quality standards.

Potential Cancer Risk

The potential cancer risk value at Fremont Elementary School, based on the main toxic air pollutants measured, was compared to the cancer risk calculated for the nearby long-term monitoring site, Fresno – 1st Street, along with the statewide air monitoring networks average. Based on the information collected in this study, the estimated cancer risk associated with the seven main toxic air pollutants (does not include diesel particulate) at Fremont Elementary School is 156 excess cases of cancer per million people exposed. In the study, cancer risk at Fremont Elementary School was approximately 11% higher than the risk calculated for the Fresno – 1st Street site, and about 25% higher than the statewide urban average. The estimated potential cancer risk represents the chances in a million of developing cancer due to breathing toxic air pollutants. Currently, there is no accepted method for measuring diesel particulates in the air. As a result, estimates from this study do not include risk from diesel particulate.

Benzene and 1,3-butadiene, the main toxic pollutants associated with cancer risk in these areas, were primarily responsible for the calculated cancer risk at both sites. The primary difference in calculated cancer risk between Fremont Elementary School and the Fresno – 1st Street site is that benzene and 1,3-butadiene levels were higher at Fremont Elementary School. Taken together benzene and 1,3 butadiene accounted for 62% of the total cancer health risk at Fremont Elementary School. In addition, both toxic pollutants accounted for 58% of the total cancer health risk at the Fresno – 1st Street site. Because motor vehicles are the primary source of both of these air pollutants, traffic near Fremont Elementary School may account for the differences in benzene and 1,3-butadiene levels.

Reducing Air Pollution in Fresno

There are numerous programs that specifically target mobile source emissions such as those found in Fresno. The ARB is responsible for developing statewide programs and strategies to reduce the emission of smog-forming pollutants and toxics by mobile sources. The ARB has programs such as the Diesel Risk Reduction Program and the California Motor Vehicle Program that help reduce air pollution from motor vehicles.

The Diesel Risk Reduction Program reduces diesel emissions from both new and existing diesel engines and vehicles. One of the key elements of the plan is to retrofit existing diesel engines in California to reduce diesel particulate emissions to near zero, in the shortest time possible. The program focuses on several control options such as the catalyst-based diesel particulate filters or traps and other viable alternative technologies and fuels. You can find more information about the Diesel Risk Reduction Plan at:
(http://www.arb.ca.gov/diesel/documents/rrpapp.htm)

The ARB also has a website that lists information on all mobile source related programs. You can find more information about these programs at:

(http://www.arb.ca.gov/msprog/msprog.htm).

The ARB will continue to evaluate the health effects of pollutants in the air while implementing programs with local authorities that aim at reducing levels of air pollution in communities such as Fresno.

For more information, contact:

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The California Air Resources Board is a part of the California Environmental Protection Agency.

The Mission of the California Air Resources Board

"To promote and protect public health, welfare, and ecological resources through the effective and efficient reduction of air pollutants while recognizing and considering the effects on the economy of the State".